Because esters can contain \(\alpha\) hydrogens they can undergo a condensation reaction similar to the aldol reaction called a **Claisen Condensation**. In a fashion similar to the aldol, one ester acts as a nucleophile while a second ester acts as the electrophile. During the reaction a new carbon-carbon bond is formed; the product is a \(\beta\)-keto ester. A major difference with the aldol reaction is the fact that hydroxide cannot be used as a base because it could possibly react with the ester. Instead, an alkoxide version of the alcohol used to synthesize the ester is used to prevent transesterification side products.

### Claisen Condensation

**Basic reaction**

\[
\text{HCO}_2\text{R} + \text{HCO}_2\text{R} \rightarrow 1) \text{NaOR} \quad 2) \text{H}_2\text{O}^+ \quad \text{\(\beta\)-Ketoester}
\]

Going from reactants to products simply

**Example 1: Claisen Condensation**

1) Enolate formation

\[
\begin{align*}
2 \quad \text{HCO}_2\text{OCH}_3 & \rightarrow 1) \text{NaOCH}_3 \quad 2) \text{H}_2\text{O}^+ \\
2 \quad \text{HCO}_2\text{OCH}_3 & \rightarrow 1) \text{NaOCH}_3 \quad 2) \text{H}_2\text{O}^+
\end{align*}
\]
2) Nucleophilic attack

3) Removal of leaving group

Dieckmann Condensation

A diester can undergo an intramolecular reaction called a Dieckmann condensation.

Example 2: Dieckman Condensation

Crossed Claisen Condensation

Claisen condensations between different ester reactants are called Crossed Claisen reactions. Crossed Claisen reactions in which both reactants can serve as donors and acceptors generally give complex mixtures. Because of this most Crossed Claisen reactions are usually not performed unless one reactant has no alpha hydrogens.
Example 3: Crossed Claisen Condensation

Contributors

- Prof. Steven Farmer (Sonoma State University)